Exhibit 20

TRIAL EXHIBIT 7326 NORTHERN DISTRICT OF CALIFORNIA UNITED STATES DISTRICT COURT

CASE NO. 10-03561 WHA DATE ENTERED______

DEPUTY CLERK

BY_



Apache Harmony: An Open Innovation

Apache Harmony Project Tim Ellison

http://harmony.apache.org



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Join me during the next 45 mins to..

current status, and future plans of the Apache Harmony project. _earn about the motivations,

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JavaOne

Agenda

Project History

Development Model

Code and Runtime Modularity

How Are We Doing?

Demo

Harmony and the JCK

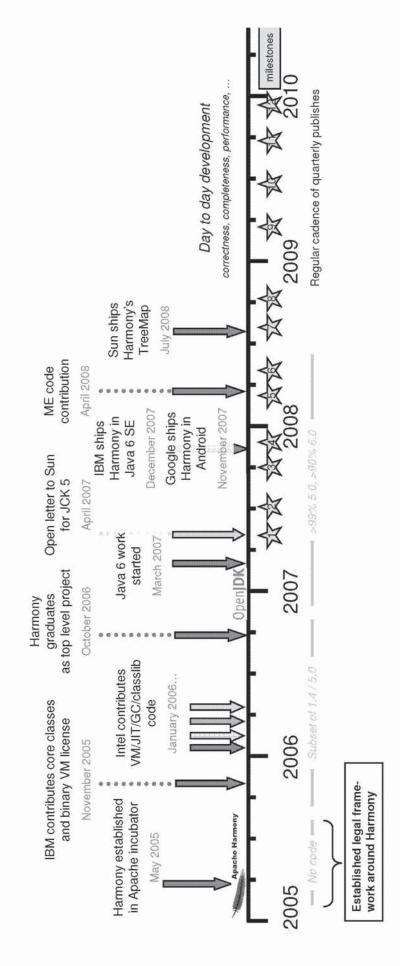
Wrap-up

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Apache Harmony

Apache Harmony — a brief history



Primary goals

- Protect IP rights of the Java ecosystem.
- Independent implementation of virtual machines, related class libraries, and other software commonly associated with Java platform implementations.
- Community-developed, modular architecture allowing sharing and innovation.

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Enhanced IP-cleanliness

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- Developers can contribute in functional areas where
- they have not studied closed-source implementations (exceptions apply).
- Existing code being contributed to the project must provide acceptable pedigree information.

This is in addition to the standard Apache contribution processes

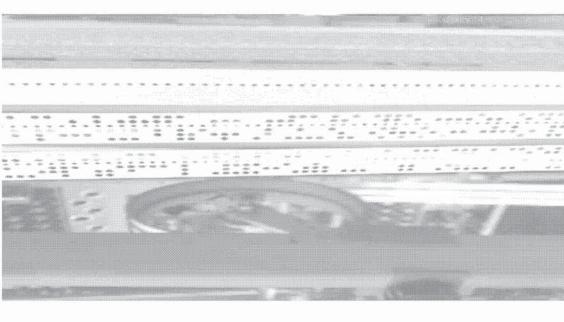
See: http://harmony.apache.org/auth_cont_quest.html

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Bootstrapping the project

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- Establish a common goal
- compliant and compatible Java SE implementation
- JVM contributions
- initial VM implementations, ... from Cobbs and Lydick
- DRLVM, ... from Intel
- Class library code contributions
- core lang, util, net, IO, beans, ... from IBM
- security, print, sound, awt, swing, ... from Intel
- math, rmi, ... from National University of Cordoba, Argentina
- Production-quality VMs for build and test
- IBM J9 and BEA JRockit were made available to project
- Used for development
- Not under open source license, not a contribution



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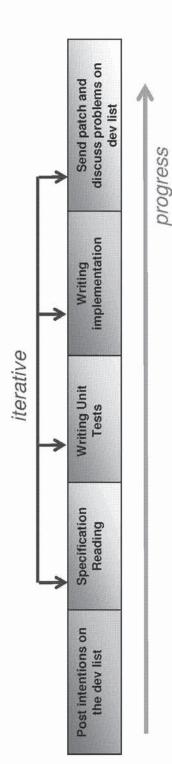
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Spec-driven development

Producing a compliant implementation



- Implementing the Java specifications as found in
- Java SE platform Javadoc
- Java Programming Language Specification
- Java Virtual Machine (JVM) Specification, etc.
- Ambiguities and omissions...
- resolved by consulting the Reference Implementation
- determined by functional API testing

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Hagour Londania

Test-driven development

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Producing a robust, compatible implementation

Functional testing

all code is guilty

- API tests, internal interfaces tests, bug regression tests
- Component oriented
- Integration testing
- Build verification, test with different VMs
- Component assembly oriented
- Application / System testing
- Running popular applications, ad hoc and test suites
- End-product and compatibility oriented
- Platform, Performance and Stress testing
- Multi-platform continuous integration, performance / stress suites
- Robustness and quality oriented

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Project repository organization

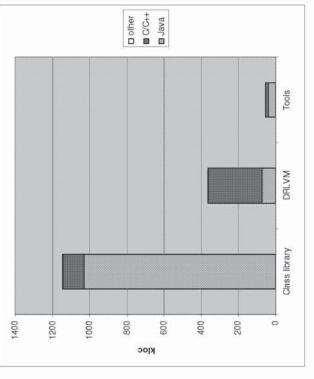
Java 5 code base is >1.5 Million non-comment lines of code

/classlib

- branches for Java 5 and Java 6 - the class library code
- the VM, JIT, GC /drlvm

/jdktools

- Java technology development tools (javac, javah, javap, ...)



generated using David A. Wheeler's 'SLOCCount'

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Federated workspace build

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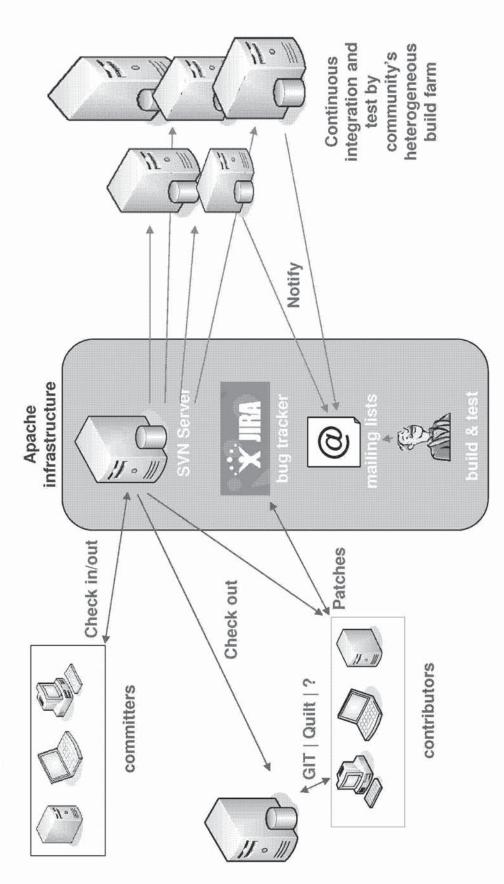
Bringing it all together

```
JIT,
                                                                               resources
                                             -> virtual machine,
                              class libraries
                                                             developer tools
                                                                             shared
                                ٨
                                                                              ٨
                                                               ٨
                                                                              /common resources
                              classlib/
                                                             /jdktools
              build.xml
                                              drlvm
/trunk
```

- Single command build, just type "ant"
- Downloads project dependencies
- Harmony Development Kit (HDK) for implementation developers, Java Development Kit (JDK) – for Java developers, Java Runtime Environment (JRE) – for Java users. Successful build results in:

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Heterogeneous build and test farm across community



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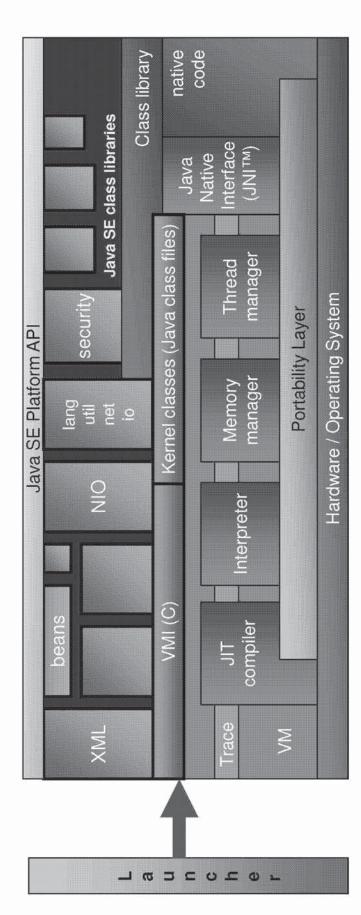
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Everything is pluggable

Architectural overview





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Harmony DRLVM - the Java Virtual Machine

- Core interpreter
- Bytecode verifier, class file loading / unloading, debug interface, JVMTI etc.
- Just in Time compilers
- profiling engine selects compiler based on typical code paths, data values, ...
- "JET" fast compiler
- ~14K NSLOC, ~10-20K methods/sec, resulting code 10x faster than interpreter
- "OPT" optimizing compiler
- multiple code transformations, resulting code 2x faster than JET
- Memory managers
- "GCv4" stop the world, sequential copying compacting
- "GCv5" stop the world, parallel copying compacting generational
- "Tick" on the fly, concurrent mark, parallel, mark-sweep-compact generational

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Virtual Machine modularity

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Code execution and memory management

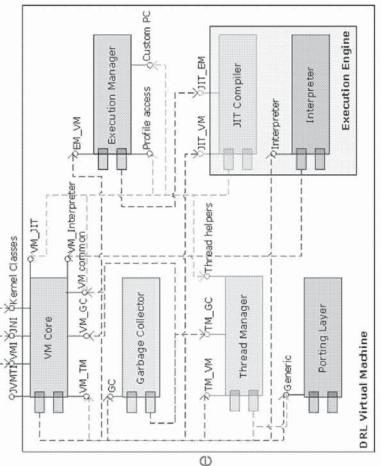


Class Libraries

across platforms

Interfaces do not compromise runtime performance Modules either build-time or runtime replaceable

Multiple implementations already exist for some modules



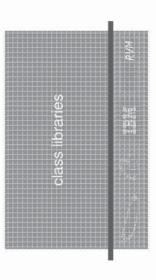
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Harmony's VIIII

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Virtual Machine Interface to the class libraries

- VM-specific 'kernel' classes
- 23 publicly defined Java SE types that the VM typically knows intimately, plus one helper
- Access to our C struct from JavaVM / JNIEnv pointers
- 10 new C functions that augment standard JNI
- The VMI provides:
- Access to the operating system abstraction library (port library)
- Access to per-VM storage functions (VMLS) which allows multiple VMs to exist in a single address space
- Ability to get/set/iterate system properties
- The VMI does not:
- Require any enhanced VM/class library linkage
- Prescribe object layout, garbage collection, synchronization, and so on



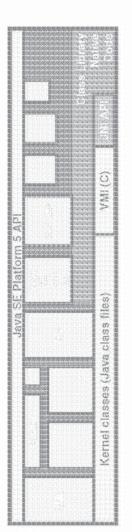
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Class library modularization

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Java SE platform implemented in ~30 components

- A module...
- is related functionality scoped by Java packages
- 'exports' user-API and internal-API, hides private internal implementation
- defined by dependencies in the Java specification
- minimizes coupling by explicit internal APIs



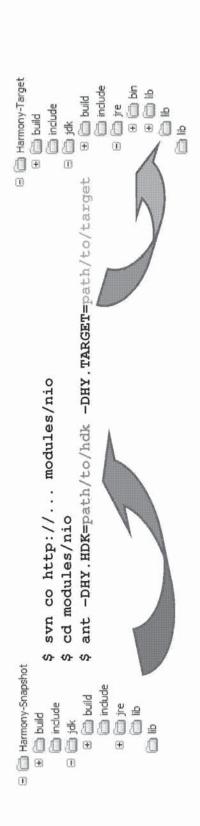
- is delivered as a JAR file, a real OSGi bundle
- Observed benefits
- easier to manage prior exposure
- freedom of assembly for module consumers
- unit of replacement for fixes and updates
- facilitates contributions

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Development time modularity

The Harmony Development Kit ("HDK")

- Not a replacement for JDK software
- HDK → Harmony developers :: JDK software → Java developers
- Contains all files necessary for Harmony development and testing
- Enables fast rebuild of individual modules Java platform and native
- Removes necessity to check out whole source tree
- Supports separate or in-place development of HDK trees



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Packaging Modularity

Software assemblies

Conventional approach

Harmony's approach

prefs-src.jar + prefs.jar + hyprefs.dll

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Multi-configuration support

"Right sized" application runtimes

Harmony's modules enable flexible assemblies:

- Apache Harmony: builds all modules into Java 5 and Java 6 configurations
- IBM Java 6 SE: a number of modules sourced from Harmony 1
- Android: core libraries adapted to run on Dalvik VM 1

accessibility			
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applet			L
archive			
auth			
awt			
beans			
concurrent			
crypto			
imageio			
Instrument			
judi			
lang-management			
logging			
luni			
math			
nio			
nio_char			
pack200			
prefs			
print			
regex			
rmi			L
security			
punos			L
sdl			
swing			
text			
xml	Xerces	KXML	
x-net			

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- Single native launcher program
- Runs command-line Java technology programs, including generic launcher and JDK software tools
- Select VM provider based on command-line option
- Select runtime specified modules (e.g. GC algorithm)

```
java -vmdir:drlvm-v1 MyClass
                                                                                                          java -vmdir:ibm-j9 MyClass
                                                                                           java MyClass
                                                            drlvm-v2,
                                             drlvm-v1,
               java.exe
                              default/
                                                                            /6i-mqi
jre/bin/
                                                                                                        S S
```

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API completeness

Our original goal - Java SE platform 5

Completeness "heat map" courtesy of JAPI tool

- None correct

All correct -

compares API compatibility

Over 99% 1.5 API complete

Missing functionality is now primarily in...

providers

sound formats encoding / decoding

Kerberos authentication

command-line tools

javadoc, javaws, jstack, native2ascii, etc.

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Harmony 6.0 96.74% 0.17% 0.15% 2.91% 0.01% Harmony 5.0 99% 0.16% 0.01% 0.8% 0% Good Minor Comparison

Bad Missing Abs.add

September 2010

See: http://kaffe.org/~stuart/japi

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Fit for Purpose Runtimes

Java technology targeting specific runtime uses

Mobile devices vs. server-grade services

Trivial headless subset for "Hello World!"

Size		27 KB	81KB	192 KB	897 KB	172 KB	1,372 KB	486 KB
Name 🌲	Diou4j_4.2.1	annotation.jar	्रश् archive.jar	ा concurrent.jar	ा luni.jar	™ nio,jar	nio_char.jar	all sequitiviar

- Virtualization
- Cloud computing platform
- Hypervisor-aware managed runtimes

Big data

Map-reduce optimized runtimes

Feature groups

Base enhancements Core technology Ul frameworks Feature XML Integration JVM & JIT JDK tools JRE tools awt datatrf annotation nio chars log ging archive crypto jdwp prefs more... Harmony Select lang-mgmt xm Fjaxp security ā text jndi nio sd DRLVM ja va more... concurrent Javac beans regex math luni isse auth m instrument xml-jaxws pack200 activation xml-stax xml-jaxb xml-saaj script tools mx jconsole webstart javadoc im ageio plugin swing punos print awt OUT orb

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Code quality

testing, bug fixing, metrics, ...

Harmony suites:

- Class library unit tests
- DRL VM unit and regression tests
- Functional test suite
- JDKTools unit tests
- Reliability test suite
- Stress test suite
- VM Validation test suite

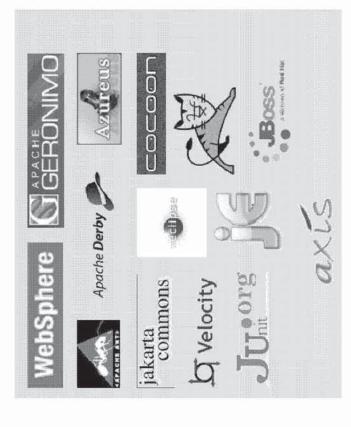
Application scenarios:

- Apache Ant scenario
- Apache Axis2 client-server scenario
- Apache Struts scenario
- Apache Tomcat scenario
- Dacapo benchmark
- Eclipse hello world application
- Eclipse Geronimo application
- JEdit scenario
- Jetty scenario
- _DAP scenario
- Scimark benchmark

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External test suites:

- Apache Ant 1.7.0 unit tests
- Apache Maven unit tests
- Eclipse unit tests.
- Eclipse TPTP tests
- Geronimo unit tests.
- JUnit tests
- Mauve fest suite



Multi-platform support

Write once, debug everywhere!

- Community builds, tests, and reports results on:
- x86 / x86 64 Windows 2000, Windows XP, Windows Server 2008
- x86 / x86_64 Debian, SLES11, RedHat AL 6, Ubuntu 10
- PPC 32bit / 64bit RedHat AL6, SLES 11, AIX6.1
- zSeries 31bit / 64 bit zLinux and zOS V1R12













Interested in other platforms? Us too!

x86 Mac OS X and FreeBSD Itanium Linux and Windows

Work in progress on:

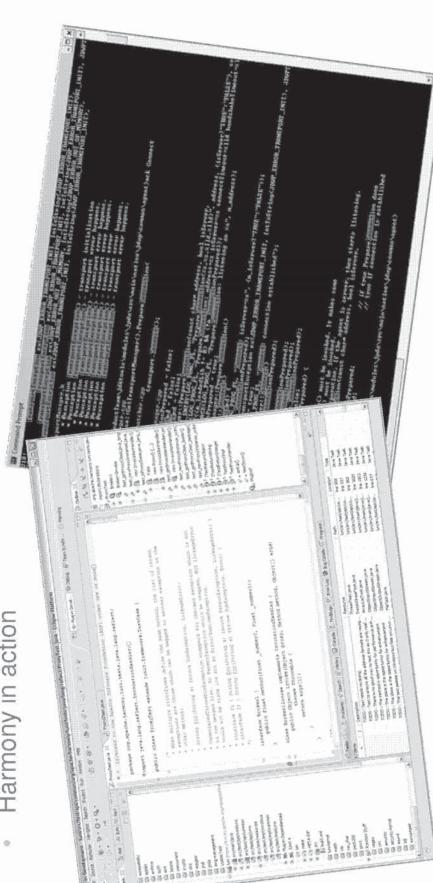
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Harmony in action



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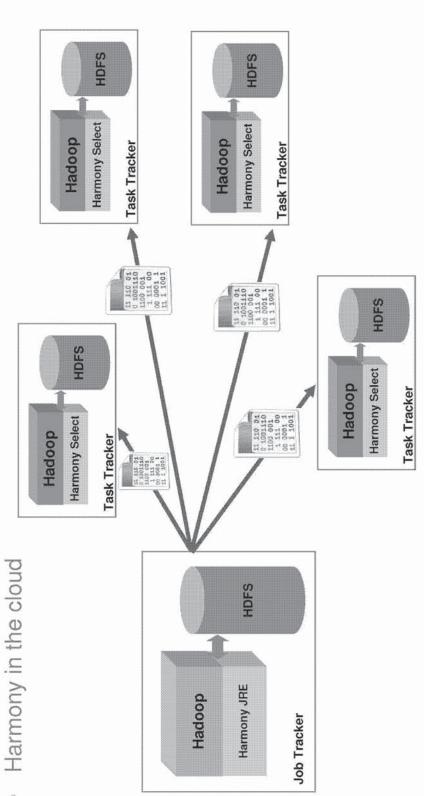
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Apache Harmony + Apache Hadoop



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- Distributed compute cluster
- Nodes running on right sized runtimes
- Harmony in the cloud



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Apache's JCK issue with Sun



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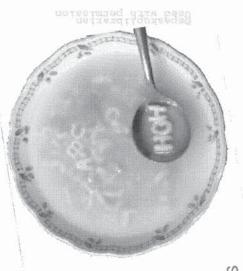
- First request for Java SE JCK v5 August 2006
- As per changes to agreement in JSPA, the "Apache Compromise"
- Sun offered JCK with FoU restrictions 3Q2006 / 1Q2007
- Limits how users can use compliant software, ASF reject as not allowing distribution simply under ALv2.



Appeal directly to Schwartz gets no response.



- The ASF will vote "no" on any proposal involving:
- JCP lead who is not complying with the JSPA
- JSRs where the TCK-license contains FoU restrictions



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Apache's JCK issue



Current position

- Last Sun offer with new terms for the JCK are still unacceptable.
- Contains FoU limitations on ASF's usage of the JCK (rather than downstream user restrictions).
- This would allow us to redistribute under ALv2.
- Sun regarding IP notice and certification requirements effectively a However, terms contain the requirement for an 'official' notice from de facto augmentation of the Apache License, and therefore unacceptable.

Apache does not make statements regarding intellectual property other than facts we explicitly know to be true and are thereby disclosed in Notice files and the Apache License.

Oracle not yet offered alternative terms

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Summary

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The best is yet to come...

- We invested time up-front getting the IP infrastructure right.
- Rapidly approaching a full compatible, open-source, implementation of Java SE.
- The core code has been picked up and used in non-trivial commercial runtimes.
- flexibility and robustness to progress Our modularity story has given us quickly and maintain stability.
- Harmony is a fountain of innovation in Java technology.



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Active areas of effort

What we still need to do ... help appreciated

- Class library providers completion
- VM performance work
- Porting to new operating systems
- Improved test case coverage
- Real-world application testing
- Community growth



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